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7 Reasons the MULTIVERSE Is NOT a Valid Alternative to God

PART 1

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Matthew 18:11
Belong in the
New Testament?**

Reasons the “Multiverse” is not a Valid Alternative to God [Part 1]

Jeff Miller, Ph.D.

Article In Brief...



The “multiverse” (i.e., the existence of many Universes) has been proposed as a substitute for God to explain the origin of our finely-tuned Universe. The multiverse, however, while not having evidence of its own to substantiate it, also hinges on other theories that have no evidence to support them. It is unscientific by definition. Further, the multiverse does not answer the ultimate question of where everything came from; it admits that naturalism is not true; and, ultimately, tacitly admits the existence of God.

IF the laws of thermodynamics indicate that the Universe could not have created itself or existed forever,¹ where did the Universe come from? If the laws themselves cannot write themselves into existence,² where did they come from? A growing number of naturalists are, ironically, recognizing that there has to be something **outside of nature** to explain the existence of the Universe. As we have shown elsewhere, there really is no such thing as a naturalist.³ Unnatural events—things which have not been shown to be able to occur in nature—**must** have occurred in the past in order to explain the natural realm (e.g., abiogenesis, laws of science writing themselves, matter/energy spontaneously generating,

non-designed design, etc., had to occur).

In order to avoid admitting that a supernatural Being exists, the theory being invoked by a growing number of naturalists is that a supernatural (though apparently God-less) realm exists called the multiverse. This multiverse is thought to explain where matter, energy, the laws of physics, and even the “mysterious” examples of “fine-tuning” we see in the Universe came from, all without resorting to the existence of God as the explanation. In the words of cosmologist Bernard Carr of Queen Mary University of London, “If you don’t want God, you’d better have a multiverse.”⁴ So, what is the multiverse? Is there evidence for the existence of such a place?

STRING THEORY: ALLEGED SUPPORT FOR THE MULTIVERSE

THE multiverse is the idea that the Universe is not the only Universe that exists: other Universes exist (10^{500} , according to string theory⁵) outside our own, and those Universes can collide, creating Big Bangs of their own.⁶ Cosmologist and Professor of Physics at California Institute of Technology Sean Carroll explained: “If conditions are just right...[parts of one Universe—JM] can undergo inflation and pinch off to form a separate universe all its own—a baby universe. Our universe may be the offspring of some other universe.”⁷

Though the multiverse is not **demand**ed by string theory, some cosmologists attempt to find support for it through string theory. Cosmologist and distinguished emeritus Professor of Mathematics and Applied Mathematics at the University of Cape Town in South Africa George Ellis, and Professor of Physics and Astronomy at Johns Hopkins University Joseph Silk said, “Fundamentally, the multiverse explanation **re**lies on string theory.”⁸ So before responding to the multiverse theory, what is string theory?

Modern physics is comprised of two branches: general relativity—physics that governs the “large” realm that we can generally see (e.g., astronomy, astrophysics, and cosmology), and a distinctly different physics that governs the “tiny” realm—namely, at the level of particles, atoms, and what makes up matter (i.e., quantum mechanics). The problem is that the physics of these two separate branches do not work together when joined. They apply only to their separate domains—not to the domain of the other. “This [realization—JM] set the stage for more than a half-century of despair as physicists valiantly

struggled, but repeatedly failed, to meld general relativity and quantum mechanics, the laws of the large and small, into a single all-encompassing description⁹—the so-called “theory of everything.”

While the concept of “string theory” has been around for several decades, persistent problems with the theory made it unpopular as a candidate for the “theory of everything.” Then in 1984, John Schwarz and Michael Green made discoveries that re-energized hope that string theory could bridge the divide between general relativity and quantum mechanics. Writing in *Discover* magazine, Steve Nadis explained, “[T]his theory attempted to unify all the known forces into a single, elegant package. Some physicists hailed string theory as the long-sought ‘theory of everything.’”¹⁰ Before string theory, the smallest, most fundamental “stuff” that were thought to make up matter (e.g., electrons, protons, neutrons, and photons) were infinitesimal, dimensionless particles—tiny dots that, unlike everything else, could not be broken down or divided into anything else and without any “internal machinery” of their own. In string theory, however, a change in the composition of the fundamental particles is hypothesized. Instead, the particles that make up matter are thought to be tiny, one dimensional, vibrating strings. How those strings vibrate determines what kind of particle something is (its mass, electric charge, nuclear properties, etc.). That might not necessarily sound far-fetched, but the fact that string theory requires the existence of six or seven unobserved dimensions—dimensions beyond those that we can perceive (i.e., length, width, height, and time)—in order for it to work,¹¹ definitely causes some physicists to scratch their heads in concern.

Regardless, according to cosmologists and physicists Paul Steinhardt,¹² Justin Khoury,¹³ Burt Ovrut,¹⁴ and Neil Turok,¹⁵ the “inspiration” for their belief in the multiverse

came from string theory, the most widespread approach to get Einstein’s general theory of relativity, which best describes space and time, to play nicely with quantum mechanics, which best describes everything else. String theory proposes that the various particles that make up matter and transmit forces are vibrations of tiny quantum-mechanical strings, including one that produces a “graviton,” an as-yet-undetected particle that transmits gravity. It also predicts the existence of extra dimensions beyond the four [i.e., length, width, height, and time—JM] of space and time we see.¹⁶

According to Ellis, “If we had proof that string theory is correct, its theoretical predictions could be a legitimate, experimentally based argument for a multiverse.”¹⁷

THE MULTIVERSE: SEVEN PROBLEMS FOR THE NATURALIST

Is the multiverse theory true? Is it even science? Does it have any

supporting evidence? Does it solve the naturalist’s problem of explaining the Universe without God?

Problem #1: String Theory

Recall that, while string theory does not necessarily imply that the multiverse is true, the multiverse “relies on string theory.”¹⁸ The first problem, then, with the multiverse hypothesis is that string theory, upon which the multiverse relies, still has no tangible evidence to substantiate it. Many physicists since Green’s and Schwarz’s discoveries

hailed string theory as the long-sought “theory of everything.” Harvard University physicist Andrew Strominger, a leader in string theory for decades...[knew] that such assertions were overblown. And, sure enough, skepticism has seeped in over the years. **No one has yet conceived of an experiment that could definitively verify or refute string theory.** The backlash may have peaked in 2006, when several high-profile books and articles attacked the theory.¹⁹

Regarding string theory as it relates to the multiverse, George Ellis said, “String theory has moved from being

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a theory that explains everything to a theory where almost anything is possible.... But string theory is not a tried-and-tested theory; **it is not even a complete theory.**"²⁰ Theoretical physicist and cosmologist of Arizona State University Lawrence Krauss admitted, "[W]e have, as of yet, no well-defined quantum theory of gravity—that is, a theory that describes gravity using the rules governing the behavior of matter and energy at the tiniest scales. String theory is perhaps the best attempt so far, but **there is no evidence that it is correct** or that it can consistently resolve all the problems that a complete quantum theory of gravity must address."²¹ Astrophysicist Eric Chaisson of the Harvard-Smithsonian Center for Astrophysics said, "Although the theory of superstrings is now causing great excitement in the physics community, there is to date **not a shred of experimental or observational evidence to support it.**"²² Tim Folger, writing in *Discover* magazine, admitted that "[a]lthough **experimental evidence for string theory is still lacking**, many physicists believe it to be their best candidate for a theory of everything."²³ Stuart Clark and Richard Webb, writing in *New Scientist*, acknowledged that "string theory has yet to make a single **testable prediction.**"²⁴

So in spite of the lack of evidence for string theory, many physicists are still holding on to hope. Notice Strominger's optimism: "String theory may not be the fabled theory of everything..., 'but it is definitely a theory of something.'"²⁵ But Silk and Ellis went further, acknowledging that string theory is "as yet **unverified....** It is not, in our opinion, robust, let alone **testable.**"²⁶ Notice that according to Silk and Ellis, not only is string theory unverified, it is not even testable. **If it is not testable, how can it**

be scientific? And if other dimensions exist according to string theory, and we cannot even observe them, how can string theory qualify as a legitimate scientific theory? To ask is to answer.

Such problems have not gone unnoticed by some physicists. In 2014 in *Nature*, Ellis and Silk wrote an article titled "Defend the Integrity of Physics," in which they rebuked theoretical physicists for the direction they have turned in their scientific endeavors regarding string theory. The need for tangible evidence before accepting a theory is becoming a thing of the past:

This year, debates in physics circles took a **worrying turn**. Faced with difficulties in applying fundamental theories to the observed Universe, some researchers called for a change in how theoretical physics is done. They began to argue—explicitly—that if a theory is sufficiently elegant and explanatory, **it need not be tested experimentally**, breaking with centuries of philosophical tradition of defining scientific knowledge as **empirical**. We disagree. As the philosopher of science Karl Popper argued: a theory must be falsifiable to be scientific. Chief among the "elegance will suffice" advocates are some **string theorists** [who rely on unobservable entities to validate their theories—JM].... These **unprovable hypotheses** [i.e., string theory and the multiverse—JM] are quite different from those that related directly to the real world and that are **testable through observations....** As we see it, theoretical physics risks becoming a no-man's land between mathematics, physics and philosophy that does not truly meet the requirements of any. The issue of **testability** has been lurking for a decade. String theory and multiverse theory have been criticized in popular books and articles.²⁷

So, string theorists are moving away from the long-standing definition of what constitutes "science." Davide Castelvecchi, writing in *Nature* in 2015, said:

String theory is at the heart of a debate over the integrity of the scientific method itself. Is string theory science? Physicists and cosmologists have been debating the question for the past decade.... For a scientific theory to be considered valid, scientists often require that there be an experiment that could, in principle, rule the theory out—or "falsify" it, as the philosopher of science Karl Popper put it in the 1930s....²⁸

According to Castelvecchi, string theory is the "principal example" of theoretical physicists straying "from this guiding principle—even arguing for it to be relaxed.... The strings are too tiny to detect using today's technology—but some argue that string theory is worth pursuing **whether or not experiments will ever be able to measure its effects**, simply because it seems to be the 'right' solution to many quandaries."²⁹

String theory is not science. It is evidence-less speculation and conjecture. And some physicists recognize that the problem is even worse than a lack of evidence for string theory:

Joe Polchinski at the University of California at Santa Barbara and Raphael Bousso at the University of California at Berkeley calculated that the basic equations of string theory have an astronomical number of different possible solutions, perhaps as many as $10^{1,000}$. Each solution represents a unique way to describe the universe. This meant that almost any experimental result would be consistent with string theory; **the theory could never be proved right or wrong**. Some critics say this realization **dooms string theory as a scientific enterprise....** String

(cont. on p. 44)

Does Matthew 18:11 Belong in the New Testament?

Q: My resources are limited to find a decent enough answer for the passage at Mt. 18:11. I would like to know why or why not it should be in our Bibles.

A: During the early centuries of Christianity, copies of New Testament books were made by Christians as those books came from the hands of the apostles. Then copies were made of copies, and then copies of copies of copies, and so on. It was inevitable that slight/minor changes would occur in some copies. In later years, New Testament books were copied by monks and even by professional copyists who did so for their living. Those who became very familiar with the synoptic Gospel accounts sometimes unnecessarily attempted to harmonize them with each other in those passages that are parallel, even though the Holy Spirit used different wording in, say Matthew, than He did in Luke, where the same incident is reported. Hence, copyists some-

times introduced words from one Gospel account into another to force them to be uniform in wording. That is clearly what happened with Matthew 18:11. Somewhere along the line, a copyist who was very familiar with Luke introduced the words of Luke 19:10 into the copy of Matthew 18 that he was making. The words are authentic from Luke's pen, but were not written by Matthew. Many manuscript copies do not contain the verse, but the copies that ultimately influenced the KJV were copies that had the interpolation introduced. Observe that no doctrine of Scripture is placed in jeopardy and no new information is added to the text by such variants in certain copies, and the original text is still preserved in the aggregate of manuscripts. See our article at: <http://apologeticspress.org/APContent.aspx?category=13&article=5196&topic=103>.

Dave Miller

The Marriage of Joseph and Mary

Q: Were Mary and Joseph actually married, just not in a consummated relationship, before they travelled to Bethlehem, or had they only had the betrothal ceremony of marriage?

A: The Jewish concept of betrothal is unique and unlike the American concept of "engaged." Under Mosaic Law, unfaithfulness during the betrothal period was tantamount to adultery and elicited the death penalty (Deuteronomy 22:23-28; Leviticus 20:10; Ezekiel 16:38; cf. John 8:5). A betrothed couple were essentially considered to be husband and wife—as evident from the fact that during the betrothal period Joseph is identified as "her husband" (Matthew 1:20). The angel instructed Joseph: "Do not be afraid to take to you Mary your wife" (vs. 20). This phrase means to "recognize her as such, and to **treat** her as such."¹ Did he obey the angel and proceed to take her as his wife? He did: "Then Joseph, being

aroused from sleep, **did as the angel of the Lord commanded him and took to him his wife**" (vs. 24, emp. added). This action of marriage preceded Jesus' birth in Bethlehem, as McGarvey observed, "several months prior to the birth of Jesus."² Though the couple was officially married prior to Jesus' birth, the text makes clear that the couple refrained from sexual relations: he "did not know her till she had brought forth her first-born Son" (Matthew 1:25).

Dave Miller

ENDNOTES

- ¹ Albert Barnes (2005), *Notes on the New Testament: Matthew and Mark* (Grand Rapids, MI: Baker), p. 6, emp. added. By "treat," Barnes meant to treat her as his wife rather than as a non-wife, with no intention to refer to the sexual relationship.
- ² J.W. McGarvey (no date), *The Fourfold Gospel* (Cincinnati, OH: Standard), p. 27.

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theory is still very much a **work in progress**.³⁰

Notice that scientists have correctly relied heavily on the ability to test, observe, and falsify scientific theories. Sadly, many scientists have moved to the extreme in their interpretation of that principle, claiming that since the supernatural realm cannot be empirically tested or observed, the existence of God or the Creation model should not be considered on the table of scientific discussion: it is essentially false by scientific definition, and pure naturalism is defined as true. The above scientists, however, are highlighting the fact that with regard to string theory, many scientists are now openly contradicting that long-held belief. But if supernatural options are now allowed in the discussion, why will these same scientists not allow the biblical explanation to be considered in the discussion, considering that the Bible has supernatural attributes and therefore provides positive evidence of the existence of the supernatural realm and its Ruler?³¹

To be clear, some physicists draw a marked distinction between string theory and the multiverse, arguing that string theory is “testable ‘in principle’ and thus perfectly scientific, because the strings are potentially detectable.”³² It may be that string theory will one day be verified, but the point is that, until it is verified, those who wish to point to the multiverse as “evidence” that God need not exist have absolutely no scientific foundation upon which to launch a campaign for the existence of the multiverse. Proponents of the multiverse hold to a belief in it without evidence—their faith is blind. Further, keep in mind, once again, even if string theory were true, it still would not mean that the multiverse is true. If string theory is not true, however, then the small shred of hope some

naturalists have that string theory could provide a starting point based in fact for proving the existence of a multiverse disappears.

Problem #2: Inflation

ACCORDING to cosmologist and Professor of Physics at Stanford University Andrei Linde, and cosmologist, physicist, and director of the Institute of Cosmology at Tufts University Alex Vilenkin, during Big Bang inflation³³ (which they believe is still on-going) “different regions of the cosmos are budding off, undergoing inflation, and evolving into essentially separate universes. The same process will occur in each of those new universes in turn.”³⁴ The multiverse theory is tied to inflation, as is Big Bang Theory, but as we have shown elsewhere, inflation has **no evidence** to support it.³⁵ Writing in *Nature* in 2014, Paul Steinhardt, “who helped develop inflationary theory but is now a scathing critic of it,”³⁶ wrote a stinging critique of inflation. His article was in response to the lack of evidence for Big Bang inflation after the then newly discovered alleged evidence for it (the discovery of Big Bang gravitational waves) was found to be false.³⁷ In the article, titled “Big Bang Blunder Bursts the Multiverse Bubble,” he argued that “[p]remature hype over gravitational waves highlights gaping holes in models for the origins and evolution of the Universe.”³⁸ He noted that the “progeny” of inflation is the multiverse, but said,

The BICEP₂ incident [i.e., the erroneously hailed discovery of Big Bang inflation gravitational waves—JM] has also revealed a truth about inflationary theory. The common view is that it is a highly predictive theory. If that was the case and the detection of gravitational waves was the “smoking gun” proof of inflation, **one would think that**

non-detection means that the theory fails. Such is the nature of normal science. Yet some proponents of inflation who celebrated the BICEP₂ announcement already insist that the theory is equally valid **whether or not gravitational waves are detected**. How is this possible? The answer given by proponents is alarming: the inflationary paradigm is so flexible that it is **immune to experimental and observational tests....** [I]nflation does not end with a universe with uniform properties, but almost inevitably leads to a multiverse with an infinite number of bubbles, in which the cosmic and physical properties vary from bubble to bubble [i.e., inflation implies a multiverse—the two stand or fall together—JM]. Scanning over all possible bubbles in the multiverse, everything that can physically happen does happen an infinite number of times. No experiment can rule out a theory that allows for all possible outcomes. Hence, the paradigm of inflation [and subsequently, the multiverse—JM] is **unfalsifiable....** [I]t is clear that the inflationary paradigm is **fundamentally untestable, and hence scientifically meaningless**.³⁹

Problem #2 for the multiverse, therefore, is that even if string theory were true, there is no evidence for Big Bang inflation—another necessary puzzle piece in multiverse theory.

Problem #3:

No Evidence for the Multiverse

EVEN if string theory and inflation had evidence to substantiate their veracity, neither theory demands that the multiverse is a reality. The multiverse needs evidence of its own to substantiate it, and it has none. That means that, by definition, belief in the multiverse (like Big Bang inflation) is irrational, according to the Law of Rationality,⁴⁰ and another

example of naturalists' blind "faith" in naturalism.

Ellis acknowledged concerning the multiverse: "We just do not know what actually happens, for we have **no information** about these regions and **never will....** All in all, the case for the multiverse is **inconclusive**. The basic reason is the extreme flexibility of the proposal: it is more a concept than a well-defined theory.... The key step in justifying a multiverse is extrapolation from the known to the **unknown**, from the testable to the **untestable**."⁴¹ Ellis and Silk noted that "[f]undamentally, the multiverse explanation **relies** on string theory, which is as yet unverified, and on **speculative mechanisms** for realizing different physics in different sister universes."⁴²

Hugh Everett is credited with first proposing the popular "Many-Worlds Interpretation" of quantum physics: "a quantum 'multiverse' in which all possible outcomes are realized in a vast array of parallel worlds." But after over 50 years since his proposal, according to theoretical physicist and professor at Columbia University Brian Greene, "we still do not know if his approach is right."⁴³ Evidence is still lacking. Michael Finkel, writing in *National Geographic*, said,

In recent years it's become increasingly accepted among theoretical physicists that our universe is not all there is. We live, rather, in what's known as the multiverse—a vast collection of universes, each a separate bubble in the Swiss cheese of reality. **This is all highly speculative**, but it's possible that to give birth to a new universe you first need to take a bunch of matter from an existing universe, crunch it down, and seal it off.⁴⁴

Theoretical physicist and cosmologist of the University of Cambridge Stephen Hawking has advanced the multiverse idea as well, but admits

that it is "still just a theory. It's yet to be confirmed by **any evidence**."⁴⁵

Astrophysicist Gregory Benford of the University of California at Irvine wrote in his book, *What We Believe but Cannot Prove*, "This 'multiverse' view represents the **failure** of our grand agenda and seems to me contrary to the prescribed simplicity of Occam's Razor, solving our lack of understanding by multiplying **unseen entities** into infinity."⁴⁶ Physicist Mark Buchanan, writing in *New Scientist*, authored an article titled "When Does Multiverse Speculation Cross into **Fantasy**?" Responding to Max Tegmark's claims about the multiverse in *Our Mathematical Universe*, Buchanan said,

Tegmark tries hard to make the seemingly **outlandish** sound almost obvious and unavoidable, and offers taxonomy to help organize a zoo of imagined parallel universes.... These other domains—or "universes"—could well exist, although we currently **have no observational evidence for them....** [T]here does seem to be something **a little questionable** with this vast multiplication of multiverses.... Multiverse champions seem quite happy, even

eager, to invoke infinite numbers of other universes as mechanisms for explaining things we see in our own universe. In a sense, multiverse enthusiasts **take a "leap of faith"** every bit as big as the leap to believing in a creator, as physicist Paul Davies put it in an article in *The New York Times*.⁴⁷

Philosopher Richard Dawid of Ludwig Maximilian University notes concerning the multiverse that "physicists have begun to use purely theoretical factors, such as the internal consistency of a theory or the absence of credible alternatives, to update estimates, **instead of basing those revisions on actual data**."⁴⁸ It is bewildering why scientists would not see Creation as a "credible alternative," considering that it is based on evidence.⁴⁹ Instead, they choose to throw out reason and make up imaginary realms without evidence. Is it possible that there is widespread bias against God in the scientific community?

There is no evidence for the multiverse, but that's not the worst of it. Not only is there no evidence, but apparently, **there can be no evidence**. Theoretical physicist at the

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Dave Miller

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University of California, Santa Barbara, David Gross makes a distinction between string theory and the multiverse and sees multiverse theory as much more troubling than string theory, “because the other universes that it postulates probably **cannot be observed** from our own, **even in principle**.”⁵⁰ Stephen Battersby, writing in *New Scientist*, stated in despair concerning the multiverse,

Our standard cosmology also says that space was stretched into shape just a split second after the big bang by a third dark and unknown entity called the inflation field. That might imply the existence of a multiverse of countless other universes **hidden from our view**, most of them unimaginably alien—**just to make models of our own universe work**. Are these weighty phantoms too great a burden for our **observations** to bear—a **wholesale return of conjecture out of a trifling investment of fact**, as Mark Twain put it?⁵¹

Notice: the other Universes of the multiverse are “hidden from our view”—unobservable “phantoms”—and yet the multiverse is needed “just to make models of our own universe work.” In other words, the existence of a supernatural realm—an unobservable reality beyond our Universe—is demanded in order to make sense of the Universe (more on that subject later).

Ellis explained:

The notion of parallel universes **leapt out of the pages of fiction into scientific journals** in the 1990s. Many scientists claim that megamillions of other universes, each with its own laws of physics, lie out there, **beyond our visual horizon**. They are collectively known as the multiverse. The trouble is that **no possible astronomical observations can ever see those other universes**. The arguments are indirect at

best. And even if the multiverse exists, it leaves the deep mysteries of nature [e.g., why does anything exist?—JM] unexplained.... All the parallel universes **lie outside our horizon and remain beyond our capacity to see, now or ever, no matter how technology evolves**. In fact, they are too far away to have had any influence on our universe whatsoever. That is why **none of the claims made by multiverse enthusiasts can be directly substantiated**.⁵²

Notice: according to Ellis, the multiverse is beyond our ability to see “**now or ever, no matter how technology evolves**.” “[N]one of the claims made by multiverse enthusiasts can be directly substantiated.” Recall that Ellis and Silk called the multiverse (and string theory) “imperceptible domains” and “unprovable hypotheses.”⁵³ In the multiverse, they say, “Billions of universes—and of galaxies and copies of each of us—accumulate **with no possibility** of communication between them or of **testing their reality**.”⁵⁴ Folger said, “For many physicists, the multiverse remains a **desperate measure, ruled out by the impossibility of confirmation**.”⁵⁵ One would think such admissions would give more scientists pause, but those bent on blindly rejecting God seem to be, literally, beyond reason on the matter.

Joshua Sokol, writing in *New Scientist*, said concerning “neighbouring universe[s] leaking into ours,” “Sadly, if they do exist, other bubbles are **nigh on impossible to learn about**.”⁵⁶ Amanda Gefter, also writing in *New Scientist*, discussed making predictions and testing them through observations in the Universe. “**That’s not possible in an infinite multiverse**: there are no definite predictions, only probabilities.”⁵⁷ Clark and Webb discuss various difficulties with the idea that there are many Universes: “The

second is how you get **convincing evidence for the existence of any of them**.”⁵⁸ Lawson Parker, writing in *National Geographic*, explained that “[i]nflation theory says our universe exploded from...[a quantum energy] fluctuation—a random event that, odds are, had happened many times before. Our cosmos may be one in a sea of others just like ours—or nothing like ours. These other cosmos will very likely **remain forever inaccessible to observation**, their possibilities **limited only by our imagination**.”⁵⁹ How convenient for naturalists to be able to propose a theory to explain away God, and that theory be immune to falsification since it is known from the start to be “forever inaccessible to observation.”

[to be continued]

ENDNOTES

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 - ¹¹ Nadis, p. 19.
 - ¹² Theoretical physicist, cosmologist, and Professor of Physics at Princeton University.
 - ¹³ Particle physicist, cosmologist, and Associate Professor and Chair of Physics and Astronomy at the University of Pennsylvania.
 - ¹⁴ High energy particle physicist, cosmologist, and Professor of Physics at the University of Pennsylvania.
 - ¹⁵ Cosmologist, physicist, and Director of the Perimeter Institute for Theoretical Physics.
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 - ¹⁷ George F.R. Ellis (2011), "Does the Multiverse Really Exist?" *Scientific American*, 305[2]:42.
 - ¹⁸ Ellis and Silk, p. 322.
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 - ²⁰ Ellis, p. 42, emp. added.
 - ²¹ Lawrence M. Krauss (2014), "A Beacon from the Big Bang," *Scientific American*, 311[4]:67, emp. added.
 - ²² Eric J. Chaisson (2001), *Cosmic Evolution* (Cambridge, MA: Harvard University Press), p. 246, emp. added.
 - ²³ Folger, emp. added.
 - ²⁴ Stuart Clark and Richard Webb (2016), "Six Principles/Six Problems/Six Solutions," *New Scientist*, 231[3092]:28-35, p. 35, emp. added.
 - ²⁵ As quoted in Nadis, p. 18.
 - ²⁶ Ellis and Silk, p. 322, emp. added.
 - ²⁷ Ellis and Silk, p. 321, emp. added.
 - ²⁸ Davide Castelvecchi (2015), "Feuding Physicists Turn to Philosophy," *Nature*, 528[7583]:446, December 24, emp. added.
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 - ⁵² Ellis, pp. 39-41, emp. added.
 - ⁵³ Ellis and Silk, p. 321.
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 - ⁵⁵ Folger.
 - ⁵⁶ Joshua Sokol (2015), "A Brush with a Universe Next Door," *New Scientist*, 228[3045]:8, October 31, emp. added.
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NOTE FROM

The Editor



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Dave Miller

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